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MILITARY SPECIFICATION

EXPLOSIVE ORDNANCE FOR SPACE VEHICLES (METRIC), GENERAL SPECIFICATION FOR

This specification is approved for use by the Department of the Air Force, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Purpose. This specification sets forth the general requirements for the design, manufacture, and testing of explosive ordnance. The requirements stated in the specification are a composite of those that have been found to be cost effective for high reliability space vehicle applications.

Beneficial comments (recommendations, additions, deletions), and any pertinent data which may be of use in improving this document should be addressed to:

USAF Space Division, SD/ALM
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Los Angeles, CA 90009-2960

Use the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or comment by letter.

AMSC N/A FSC 1820

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1.2 Application. The requirements covered by this specification are applicable to explosive ordnance which includes initiators, explosive transfer assemblies, cartridge actuated devices, safe and arm devices, destruct charges, and other elements of explosive trains. This specification is intended for reference in space vehicle specifications to incorporate the general requirements which are common to space vehicle explosive ordnance. This general specification is also intended as the basis of detailed specifications for particular explosive ordnance components; This specification may also be used to specify requirements for explosive ordnance to be used on launch vehicles, intercontinental ballistic missiles, or other vehicles (see 6.1). For those applications the term "space vehicle** is to be interpreted as the applicable vehicle or equipment.

2. APPLICABLE DOCUMENTS

2.1 Government Documents

2.1.1 Specifications, Standards, and Handbooks. The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS:

Federal

QQ-N-290	Nickel Plating (Electrodeposited)
QQ-C-320	Chromium Plating (Electrodeposited)

Military

MIL-M-3171	Magnesium Alloy, Processes for Pretreatment and Prevention of Corrosion on
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-H-6088	Heat Treatment of Aluminum Alloys
MIL-H-6875	Heat Treatment of Steel (Aircraft Practice) Process for
MIL-F-7179	Finishes and Coatings, General Specification for Protection of Aerospace Weapons Systems, Structures and Parts

MIL-S-7742	Screw Threads, Standard, Optimum Selected Series, General Specification for
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-S-13572	Spring, Helical, Compression and Extension
MIL-C-26074	Coatings, Electroless Nickel, Requirements
MIL-M-45202	Magnesium Alloys, Anodic Treatment of
MIL-H-81200	Heat Treatment of Titanium and Titanium Alloys

STANDARDS

Military

MIL-STD-29	Springs, Mechanical; Drawing Requirements for
MIL-STD-889	Dissimilar Metals
MIL-STD-1167	Ammunition Data Card
MIL-STD-1168	Lot Numbering of Ammunition
MIL-STD-1246	Product Cleanliness Levels and Contamination Control Program
MIL-STD-1515	Fasteners for Use in the Design and Construction of Aerospace Mechanical Systems
MIL-STD-1540	Test Requirements for Space Vehicles
MIL-STD-1568	Materials and Processes for Corrosion Prevention and Control in Aerospace Systems
MIL-STD-1576	Electroexplosive Subsystem Safety Requirements and Test Methods for Space Systems
MS-33540	Safety Wiring and Cotter Pinning, General Practices for

2.1.2 Other Government Documents, Drawinas, and Publications. The following other government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

SP-R-0022	Vacuum Stability Requirements of Polymeric Materials for Spacecraft Applications (NASA JSC)
SAMTO HB S-100	Space Transportation System Payload Ground Safety Handbook (Joint NASA/Air-Force document designated by NASA as KHB 1700.7)
WSMCR 127-1	Range Safety Regulation (USAF Western Space and Missile Center)
ESMCR 127-1	Range Safety Regulation (USAF Eastern Space and Missile Center)
MSFC-SPEC-522	Stress Corrosion Cracking Control (NASA MSFC)
KHB 1700.7	Space Transportation System Payload Ground Safety Handbook (Joint NASA/Air Force document designated by the Air Force as SAMTO HB S-100)
NHB 1700.7	Safety Policy and Requirements for Payloads Using the Space Transportation System (STS) (NASA)
NAVORD 2101	Statistical Methods of Evaluation of Fuze Explosive Train Safety and Reliability

(Copies of specifications, standards, handbooks, drawings, publications, and other government documents required by contractors in connection with specific acquisition functions should be obtained from the acquisition activity or as directed by the acquisition activity.)

2.2 Nonuovernment Documents. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING MATERIAL

ASTM E 595-84	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Material From Outgassing in a Vacuum Environment

Application for copies should be addressed to: American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19111

2.3 Order of Precedence In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence, Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Flightedítatíon. Explosive ordnance furnished under this specification, or under associated detail specifications, shall be flight accredited. Items are considered to be flight accredited if the items satisfy all of the following conditions:

a. All items meet the requirements for parts, materials and processes and the manufacturing screens (see 4.3).

b. The items have passed the specified design verification tests (see 4.4).

c. The items have passed the qualification test requirements (see 4.5).

d. The items are from a production lot that passed the specified lot acceptance tests (see 4.6). Government furnished (GFE) explosive ordnance, whether DOD or NASA, are not exempt from this requirement. If prior lot acceptance testing has not met the requirements contained herein, testing shall be conducted to demonstrate compliance.

e. The items have been transported and stored within the specified environmental limits. (see 3.4.3).

f. The items are from a production lot that have a verified service life for the scheduled operational use (see 4.7).

3.2 General Desisn Requirements.

3.2.1 Selection of Parts, Materials, and Processes. Unless otherwise specified in the contract, the parts, materials, and processes shall be selected and controlled in accordance with contractor established and documented procedures to satisfy the requirements specified herein. The selection and control procedures shall emphasize quality and reliability to meet the mission requirements and to minimize total life cycle costs for the applicable system. An additional objective in the selection of parts, materials, and processes shall be to maximize commonality and thereby minimize the variety of parts, related tools, and test equipment required in the fabrication, installation, and maintenance of the vehicle. However, identical electrical connectors, identical fittings, or other identical parts shall not be used on a space vehicle where inadvertent interchange of the items or interconnections could cause possible malfunction. The parts, materials, and processes selected shall be of sufficient proven quality to allow the space equipment to meet the functional performance, safety, reliability, contamination, and strength requirements during its life cycle including all environmental degradation effects. Parts, materials, and processes shall be selected to ensure that any damage or deterioration from the environment, or the outgassing effects in the space environment, would not create a safety hazard or reduce the performance of the space vehicle beyond the specified limits.

3.2.1.1 Explosive Materials. Explosive materials that are in accordance with military or federal specifications or standards shall be used, where practicable. Material in accordance with other specifications, including proprietary compositions, that may result in superior performance, increased reliability, or improved safety may be used if approved by the acquisition activity.

3.2.1.1.1 Upper Temperature Limits. The decomposition, cook-off, and melting temperatures of all explosives shall be at least 30 deg C higher than the maximum predicted environmental temperature to which the material will be exposed during storage, handling, installation, transportation, launch, or on orbit.

3.2.1.1.2 Primary Explosives. The use of sensitive primary explosives shall be kept to a minimum consistent with achieving reliable performance.

3.2.1.2 Inert Materials. Materials shall be selected that have demonstrated their suitability, for the intended application. Inherently fungus-inert materials shall be used, where practicable. Combustible materials or materials that can generate toxic outgassing or toxic products of combustion shall not be used if cost-effective alternatives exist.

Materials shall be selected for low outgassing in accordance with SP-R-0022 (NASA JSC). The total mass loss shall be less than 1 percent, and the collected volatile condensable material shall be less than 0.1 percent when heated in vacuum (0.0001 Torr) to 125 deg C (257 deg F) and collected at 23 deg C (73 deg F). The hygroscopic nature of many materials such as composites, electroformed nickel, and anodic coatings for aluminum should be recognized, if they are used, since they emit water in a vacuum and therefore may be unsuitable for some applications.

Metals shall be corrosion resistant, or shall be suitably treated to resist corrosion when subjected to the specified environments. Protection of dissimilar metal combinations shall be in accordance with MIL-STD-889. Care shall be exercised in the selection of materials and processes in accordance with MSFC-SPEC-522 and MIL-STD-1568 to avoid stress corrosion cracking and brittle fracture failure modes, and to preclude failures induced by hydrogen embrittlement. For example, aluminum alloys 2020-T6, 7079-T6, and 7178-T6 shall not be used for structural applications. The following alloys and heat treatments shall not be used in applications where the temperature exceeds 65 deg C: 5083-H32; 5083-H38; 5086-H34; 5086-H38; 5456-H32; and 5456-H38. Heat treatment of aluminum alloy parts shall be in accordance with MIL-H-6088. Heat treatment of steel parts shall be in accordance with MIL-H-6875. Heat treatment of titanium and titanium alloys shall be in accordance with MIL-H-81200. All high strength steel parts heat treated at or above 1241 megapascals (180,000 pounds per square inch) ultimate tensile strength shall include appropriate test specimens from the same heat of material as the part. These test specimens shall accompany the parts through the entire fabrication cycle to ensure that the desired properties are obtained. Note that some high strength steels are susceptible to stress corrosion cracking and should not be used.

Materials with low fracture toughness in the predicted operating environment, such as that exhibited by some plastics, shall not be used. Materials which are susceptible to cracking due to shock loads, or shock loads combined with low temperatures, shall not be utilized.

3.2.1.3 Finishes. The finishes used shall be such that completed components shall be resistant to corrosion. The design goal should be that there would be no destructive corrosion of the completed components or assemblies when exposed to moderately humid or mildly corrosive environments while unprotected during manufacture or handling, such as possible industrial environments or sea coast fog that could be expected prior to launch. Destructive corrosion shall be construed as being any type of corrosion which interferes with meeting the specified mechanical, thermal, or electrical performance of the equipment or its associated parts. Protective methods and materials for cleaning, surface treatment, and applications of finishes and protective coating shall be in accordance with MIL-F-7179. Cadmium and zinc coatings shall not be used. Chromium plating shall be in accordance with QQ-C-320. Nickel plating shall be in accordance with QQ-N-290 or MIL-C-26074. Anodic treatment of aluminum and aluminum alloys shall be in accordance with MIL-A-8625. Anodic treatment of magnesium shall be in accordance with MIL-M-45202. Corrosion protection of magnesium shall be in accordance with MIL-M-3171. Chemical films for aluminum and aluminum alloys shall be in accordance with MIL-C-5541.

3.2.2 Lubricants. Explosive ordnance may use lubricants if the design and manufacturing processes assure that no lubricant can come in contact with explosive materials. Lubrication may be provided by greases or by solid film lubricants or a combination of both. Lubricants shall be selected with consideration given to corrosion, outgassing, temperature limits, operation in a vacuum; creep properties, effect of long term storage, and compatibility with other lubricants and materials.

3.2.3 **Springs**. Helical springs shall be in accordance with MIL-S-13572 and MIL-STD-29. Helical compression springs are preferred to helical tension springs. Helical compression springs shall, where practicable, be enclosed or otherwise captivated to prevent buckling, and to provide motive power even if broken. The attachments for retaining leaf springs shall be designed to reduce stress concentrations by such features as rounding of sharp corners or keeping mounting holes away from highly stressed areas. Spring design shall consider fatigue life and the effects of temperature on spring performance. To reduce the possibility of a reduction of potential energy due to creep, springs which are stored in a stressed condition shall be designed to maintain stress levels below the material proportional limit. Redundant springs, capable of working independently, shall be used in all applications, where practicable. When minimum friction is desirable, springs shall be dry film lubricated. The dry film lubricant shall be selected to avoid corrosion, and shall not contain carbon or metal.

3.2.4 Fasteners and **Locking**

3.2.4.1 Threaded, Parts. Fastening systems shall be in accordance with MIL-STD-1515. Threaded parts shall be in accordance with MIL-S-7742 or MIL-S-8879. A minimum engagement of five full threads is required for threaded attachments; or for through bolts, the threaded ends shall protrude a minimum of two full threads beyond the end of the nut. Screw sizes smaller than 3.6 millimeters (No. 8) in diameter shall be avoided, where practicable. Where there are areas which may be sensitive to debris generated during assembly of threaded parts, blind holes should be considered. Tolerances shall be controlled to prevent threaded parts from bottoming in blind holes.

3.2.4.2 Locking Devices. Positive locking devices shall be used on all fasteners. Preferred positive locking devices are bent tab washers, cotter pins, safety wire, self-locking threads or self-locking provisions by means of plastic material contained in the nut, bolt, or screw. Self-locking nuts are preferred to bolts or screws that contain plastic material for use as a locking device. Where other locking devices are practicable, locking compounds shall not be used on fasteners to provide locking. Also, locking compounds shall not be used in areas where excess compound could migrate to surfaces which must remain free to move. Self-locking devices which depend upon an interference fit between metallic threads shall be avoided, where practicable, in applications where particulate contamination may cause damage or degradation to the equipment or vehicle. Where preload in fasteners is critical, strain gauges, crush washers, or equivalent techniques shall be used, where practicable, in lieu of torque wrench setting of the preload. Safety wiring and cotter pins shall be in accordance with MS-33540. Drawings shall clearly depict the safety wiring method and configuration used. Through bolts or screws with locknuts are preferred to threaded inserts. Threaded inserts shall be used in applications that require tapped holes in aluminum, magnesium, plastic, or other materials that are susceptible to galling or thread damage. When self-locking features are used, the screw length shall be sufficient to fully engage the locking device with a minimum of two turns under worst case tolerances. When self-locking features are used, an allowable range of run-in torque shall be specified or the maximum number of reuses that will still ensure an adequate lock shall be specified. Spring type or star type lock washers shall not be used. Adjustable fittings or mounting plates which use oversized holes or slotted holes to provide adjustment shall not be dependent upon friction between the fitting or mounting plate and the mounting surface to provide locking. Diamond type serrations shall not be used.

3.2.5 Stops. Mechanical stops or shoulders and associated attachments shall be designed to a structural yield factor of safety based on static analysis, of at least 2.0 for maximum impact loads that occur upon full extension, actuation, or stopping of moving assemblies. A snubbing arrangement which dissipates energy may be provided where necessary to reduce the impact forces.

3.2.6 **Size and Weight**. The size and weight of all components shall be kept to a minimum consistent with meeting the specified performance, safety, and reliability requirements under all environmental conditions.

3.2.7 Sealing. Where practicable, explosive ordnance shall be sealed to ensure protection from external environments.

For sealed units, the maximum leak rate using helium shall be less than 0.01 atmospheric cubic millimeters per second when subjected to a pressure differential of 101.3 ± 10 kilopascals.

3.2.8 Redundancy. All mission critical explosive ordnance functions on a space vehicle shall be designed so that a failure of any single explosive element to operate will not cause a failure of the function.

3.2.8.1 Cartridue Actuated Devices. Redundant cartridge actuated devices shall be used to perform a function whenever practical. When vehicle design considerations necessitate the use of a single cartridge actuated device to perform a function, dual electroexplosive devices (EEDs) shall be used. The firing of either one or both EEDs shall provide operational success. The firing of the first EED shall have no detrimental effect on the redundant EED.

3.2.8.2 Exolosive Trains. Redundant explosive charges shall be used where practicable. Each explosive charge shall be detonated by a minimum of two initiators. Linear explosive charges shall have at least one initiator at each end of the charge. Explosive trains containing cylindrical donor and receptor charges shall use the end-to-end detonation transfer mode, where practicable. Designs which preclude use of the end-to-end transfer mode may use end-to-side or side-to-end, in that order of preference. Side-to-side detonation transfer shall not be employed. Detonating interconnects or crossovers shall not be used between redundant explosive trains unless approved by the acquisition activity.

3.2.8.3 Dual Briduewire EEDs. Dual bridgewire EEDs shall not be considered redundant elements in an explosive train.

3.2.9 Tolerances. Tolerances shall be established to ensure that proper clearances are maintained under worst case service conditions. Dimensions and tolerances shall be such as to reduce to a practical minimum the variations between units.

3.2.10 Linear Shaped Charues. Charge holders shall be used for all linear shaped charge functions to insure proper charge orientation.

3.3 Performance Requirements

3.3.1 Cartridge Actuated Device Marqins

3.3.1.1 Minimum Charae Weisht. All cartridge actuated devices shall be capable of performing their end function when actuated by a single cartridge containing an explosive charge which is 80 percent or less of the minimum specified explosive charge weight. This requirement applies to both single and dual cartridge actuated devices.

3.3.1.2 Maximum Charge Weight. All cartridge actuated devices shall be capable of performing their end function when actuated by an explosive charge which is at least 120 percent of the maximum specified charge weight and with no increase in the initial free volume without rupture.

3.3.1.3 Mechanical Load. All cartridge actuated devices which are required to function while under a load, either tension, compression, or shear, shall have the ability to operate satisfactorily both unloaded and when loaded to at least 1.5 times the maximum predicted operating load.

3.3.2 Severing and Penetratins Device Margins. Severing and penetrating devices shall be designed to sever or penetrate the required maximum thickness of the specified material using 67 percent or less of the minimum specified severing charge weight at the maximum standoff.

3.3.3 EED Characteristics. EEDs shall be designed such that the "All-fire" current does not exceed 50 percent of the minimum supplied operating current measured at the EED.

3.3.3.1 "All-fire" Current. All EEDs shall fire with a reliability of 0.999 at 95 percent confidence when activated with the specified "All-fire" current and at any higher current level up to and including 22 amperes.

3.3.3.2 "No-fire" Current. The EED shall not fire when the bridgewire is subjected to the "No-fire" current. Unless otherwise specified, the "No-fire" current shall be a current of 1 ampere applied for 5 minutes. Firing probability when subjected to the "No-fire" current shall be less than 0.001 at 95 percent confidence level. Following exposure to this "No-fire" current, the EED shall be capable of performing as specified herein.

3.3.3.3 "No-fire" Power. The EED shall not fire when the bridgewire is subjected to the "no-fire" power. Unless otherwise specified, the "No-fire" power shall be a dc power of 1 watt for 5 minutes. Firing probability when subjected to this "No-fire" power shall be less than 0.001 at 95 percent confidence level. Following exposure to this "No-fire" power, the EED shall be capable of performing as specified herein.

3.3.3.4 Static Sensitivity. EEDs shall not fire or deteriorate in performance as a result of being subjected to an electrostatic discharge of 25,000 volts from a 500 picofarad capacitor applied in the pin-to-case mode with no series resistor and in the pin-to-pin mode with a 5K ohm resistor in series. EEDs using an external spark gap require acquisition activity approval.

3.3.3.5 Insulation Resistance. The insulation resistance between shorted pins and case shall be at least 2 megohms when measured with the application of 500 volts dc. (For testing the NASA Standard Initiator, 250 volts potential may be used.)

3.3.4 Percussion Initiators. Percussion initiators shall be designed such that the "All-fire" energy does not exceed 50 percent of the minimum supplied operating energy. The "No-fire" energy shall be such that the percussion initiator shall not fire when subjected to an energy of 50 percent of the "All-fire" energy.

3.3.5 Detonatina Components. Detonating components, which include through bulkhead initiators, safe arm device rotor leads and explosive transfer assemblies, shall perform with a demonstrated margin.

3.3.5.1 Throush Bulkhead Initiators. Through bulkhead initiators shall demonstrate the ability to propagate the shock front through a bulkhead that is 1.2 times the maximum thickness, and initiate the receptor charge.

3.3.5.2 Detonation Transfer. The propagation of detonation from one detonating element to another shall be demonstrated for both donor and receptor elements. The ability of an explosive element to perform as a donor or receptor charge shall be demonstrated by initiating the specified receptor charge using the specified donor charge through a gap at least 4 times the maximum specified gap or through a 2.54 millimeters (0.10 inch) gap, whichever is greater.

3.3.6 Safe and Arm Devices. All safe and arm devices shall meet the safety and performance requirements of MIL-STD-1576.

3.4 Environmental Design Requirements. To provide a design factor of safety or margin, the explosive ordnance shall be designed to function within performance specifications when exposed to environmental levels that exceed the extreme levels predicted during its service life by the specified margins. The maximum predicted environments shall be determined in accordance with the definitions in MIL-STD-1540.

3.4.1 Nonoperational Environments. Explosive ordnance shall be designed to function within performance specifications, and shall not prematurely operate after exposure in the nonoperational configuration to environmental levels that exceed the extremes of the predicted nonoperational environments by the design factor of safety or design margin. These nonoperational environments include temperature, humidity, handling shock, random vibration, acceleration, radiation, and pressure.

3.4.1.1 Temperature. The design shall be capable of surviving thermal environments that are between 30 deg C above the maximum temperature and 10 deg C below the minimum temperature predicted during storage, handling, transportation, launch preparation, and launch.

3.4.1.2 Humidity. Where practicable, the design shall be capable of surviving exposures to moderately humid or mildly corrosive environments, such as industrial environments or sea coast fog.

3.4.1.3 Handlins Shock. Explosive ordnance items shall be capable of being dropped from a height of 2.0 ± 0.3 meters onto a 50 ± 1.0 millimeter thick steel plate without causing detonation or performance degradation.

3.4.1.4 Shock. The design shock spectrum shall be at least 6 dB over the maximum predicted transient and pyrotechnically induced shock levels.

3.4.1.5 Random Vibration. A random vibration design environment that is 6 dB above the maximum predicted levels shall be used to provide the required design margin of safety. This design environment shall be considered to persist for three times the exposure duration, but for not less than 3 minutes, along each of the three orthogonal axes. The exposure duration is defined as the time associated with the environmental amplitudes that are greater than one half the maximum predicted environmental amplitudes.

3.4.1.6 Acceleration. The design acceleration level shall be at least 20 g applied in any direction.

3.4.1.7 Radiation. The design shall be capable of surviving the maximum predicted electromagnetic, nuclear, and radiation belt radiation levels estimated to occur prior to functioning.

3.4.1.8 Pressure. The design shall be capable of surviving ambient pressures that range between 0.20 megapascals and 133 micropascals.

3.4.2 Operational Environments. Explosive ordnance shall be designed to function within performance specifications when exposed in the operational configuration to environmental levels that exceed the maximum predicted operational environments by the design factor of safety or design margin. These operational environments include temperature, random vibration, acceleration, and pressure.

3.4.2.1 Temperature. Explosive ordnance shall operate at any temperature within their thermal design range. Unless otherwise specified, the thermal design range is from 10 deg C above the maximum predicted operational temperature to 10 deg C below the minimum predicted operational temperature. In addition, the thermal design range shall not be less than from +71 deg C to -57 deg C.

3.4.2.2 Random Vibration. Explosive ordnance shall be capable of operating while exposed to random vibration levels that are at least 6 dB above the maximum predicted operational levels.

3.4.2.3 Pressure. The design shall be capable of operating in environments which range from a pressure of 0.20 megapascals to pressures that are less than 133 micropascals.

3.4.3 Fabrication, Storage, Transportation, and Handling Environments. Fabrication and handling of explosive ordnance shall be accomplished in a clean environment. Environmental conditions during fabrication, storage, handling, and transportation shall be within the following limits:

a. Temperature: 21 deg C ± 20 deg C

b. Humidity: 50 percent ± 20 percent

3.5 Identification and Marking. Data cards shall be prepared for each item in accordance with MIL-STD-1167. Where practicable, explosive ordnance shall be identified by a nameplate. This marking is in addition to the identification provided by the data card which accompanies the item.

3.5.1 Nameplate. The nameplate identification may be attached to, etched in, or marked directly on the item. The nameplate shall utilize suitable letter size and contrasting colors, contrasting surface finishes, or other techniques to provide identification that is readily legible. The nameplate shall be capable of withstanding cleaning procedures and environmental exposures anticipated during the service life of the item without becoming illegible. Metal foil nameplates may be applied if they can be placed in an area where they cannot interfere with proper operation should they inadvertently become detached. Metal stamping shall not be used. Where practicable, identification nameplates on components and subassemblies shall be in locations which permit observation of the marking at the next higher level of assembly. Nameplates shall contain, as a minimum, the following:

a. Item identification number

b. Serial number

c. Lot number

d. Manufacturer

e. Nomenclature

The marking of any two or more items intended for space applications with the same item number or identification shall indicate that they may be capable of being changed, one for another, without alteration of the items themselves or of adjoining equipment if the items also meet the specified flight accreditation requirements.

3.5.2 Data Cards. When size limitations, cost, or other considerations preclude marking all applicable information on an item, the nameplate may simply provide a reference key to cards or documents where the omitted nameplate information may be found. A copy of the referenced nameplate information or card shall accompany the item or assembly containing the item during ground tests and ground operations.

3.5.3 "NOT FOR FLIGHT" Marking. Items which by intent or by material disposition are not suitable for use in flight, and which could be accidentally substituted for flight or flight spare hardware, shall be red tagged or striped with red paint, or both, to prevent such substitution. The red tag shall be conspicuous and marked "NOT FOR FLIGHT." The red paint shall be material compatible and the stripes unmistakable.

3.6 Interface Requirements The installation and operation of explosive ordnance shall have no detrimental effect on adjacent equipment.

3.6.1 Fragmentation. There shall be no deleterious fragmentation resulting from the operation of any explosive ordnance.

3.6.2 Contamination. There shall be no deleterious contamination resulting from the operation of explosive components. Where the component design does not ensure the containment of the generated gas, the components shall be mounted in locations or orientations where escaping gases cannot impinge on optical sensors or thermal control surfaces.

3.6.3 Shock. The shock generated by the operation of explosive ordnance shall be minimized to the extent practical.

3.7 **Operability**

3.7.1 Reliability. The design reliability goal for successful operation of explosive ordnance shall be 0.995 at 95 percent confidence. If a higher reliability is required by a program, the higher figures shall be specified in the detailed specification.

3.7.2 Maintainability. All explosive ordnance shall be designed so as not to require any scheduled maintenance or repair during their service life. The designs shall accommodate easy installation, testing, or replacement at the launch site. Where practicable, explosive ordnance shall not be located in assemblies which must be removed and replaced for the normal maintenance of other nonexplosive items.

3.7.3 Human Ensineering. Throughout the design and development of explosive ordnance, criteria shall be judiciously applied to obtain effective, compatible, and safe man-equipment interactions. Provisions such as tabs, shoulders, and different thread sizes shall be employed to prevent assembly in any incorrect manner which may impair the intended functions.

3.7.4 Service Life. Explosive ordnance shall have a service life commensurate with mission requirements. The contractor shall identify age sensitive materials and shall implement service life surveillance of the age sensitive materials in accordance with a plan approved by the acquisition activity.

3.7.5 Interchanseability. To the extent practicable, the design of the items shall make provisions for the factory replacement of subassemblies or parts.

3.7.6 **Safety**

3.7.6.1 General The design of explosive ordnance for space vehicles shall be such as to minimize the accident risk to personnel, equipment, and facilities. Ordnance handling, installation, and storage procedures shall be formally documented and shall have appropriate cautions and warnings as determined by ordnance safety personnel. Safety requirements shall be established such as their implementation can be verified during all activities. The safety requirements and procedures shall comply with all local, state, and federal requirements. Compliance with applicable Range safety documents, ESMCR 127-1, WSMCR 127-1, SAMTO HB S-100 (KHB 1700.7), and MIL-STD-1576, is required.

3.7.6.2 Space Transportation System Payload Ordnance. Explosive ordnance and firing circuits employed in payloads to be operated in the Space Transportation System and flown on the space shuttle vehicle shall meet the Chapter 2 requirements of NASA Handbook NHB 1700.7. In addition, Chapter 2 of NASA Handbook NHB 1700.7 defines safety requirements that are applicable for hazardous materials, pyrotechnics, destruct subsystems, and other space equipment.

3.8 Manufacturing

3.8.1 Processes and Controls. The manufacturing of explosive ordnance devices shall be accomplished in accordance with documented procedures and process controls which assure the reliability and quality required. These manufacturing processes and controls shall provide a supplier controlled baseline that assures subsequent production items can be manufactured that are equivalent in performance, quality, and reliability to initial production items used for qualification or for flight. These process controls shall be documented to give visibility to the procedures and specifications by which all processes, operations inspections, and tests are to be accomplished by the supplier. This internal contractor documentation shall include the name of each part or component, each material required, the point it enters the manufacturing flow, and the controlling specification or drawing. The documentation shall indicate required tooling, facilities, and test equipment; the manufacturing check points; the quality assurance verification points; and the verification procedures corresponding to each applicable process or material listed. The specifications, procedures, drawings, and supporting documentation shall reflect the specific revisions in effect at the time the item(s) used for qualification were produced. When approved by the acquisition activity, these flow charts and the referenced specifications, procedures, drawings, and supporting documentation become the manufacturing process control baseline and shall be retained by the supplier for reference. It is recognized that many factors may warrant making changes to this documented baseline; however, all changes to the baseline processes used, or the baseline documents used, shall be recorded by the supplier following the production of the first lot. These changes provide the basis for flight accreditation of subsequent production lots so the changes should be approved by the acquisition activity or his designated representative.

3.8.2 Production Lots. Explosive ordnance items shall be grouped together in individual production lots during the various stages of manufacturing to assure that all items in a production lot are assembled during the same time period using the same production materials, tools, methods, personnel, and controls. Each production lot shall be loaded with explosive materials manufactured, tested, and stored as a single batch. Lot numbers shall be assigned to each production lot of explosive ordnance in accordance with MIL-STD-1168. A serial number shall be assigned to each item in each lot at an appropriate point in the manufacturing flow.

3.8.3 Contamination

3.8.3.1 Fabrication and Handling. Fabrication and handling of space equipment shall be accomplished in a clean environment. Attention shall be given to avoiding nonparticulate (chemical) as well as particulate air contamination. To avoid safety and contamination problems, the use of liquids shall be minimized in powder loading areas, or areas where initiators, explosive bolts, or any loaded explosive devices are exposed.

3.8.3.2 Device Cleanliness. The particulate cleanliness of internal moving subassemblies shall be maintained to at least level 500 as defined in MIL-STD-1246. External surfaces shall be visibly clean. The allowable product nonvolatile residue (NVR) level shall be maintained to at least level "G", as defined in MIL-STD-1246. Specific cleanliness requirements shall be determined for each assembly based on an analysis of overall system cleanliness requirements.

3.8.4 **Electrostatic Discharge.** Provisions shall be made to avoid and protect against the effects of static electricity generation and discharge in areas containing explosives.

3.8.5 Independent Monitoring. Facilities and inspection stations shall be provided in the manufacturing area for the surveillance and monitoring of critical operations by an independent organization approved by the acquisition activity..

3.8.6. Refurbishment. Explosive ordnance components, including cartridge actuated devices, shall be considered one-shot items. They shall not be refurbished for vehicle use after firing. Units refurbished for use in special ground tests shall be clearly identified as "NOT FOR FLIGHT" (see 3.5.3).

3.8.7 Craftsmanship. Explosive ordnance shall be manufactured, processed, tested, handled, and installed such that the finished items are of sufficient quality to ensure reliable operation, safety, and service life. The items shall be free of defects that would interfere with operational use such as excessive scratches, nicks, burrs, loose material, contamination, and corrosion.

3.9 Storase and Handling Provisions Storage, handling, and transportation conditions to which explosive ordnance are to be subjected prior to flight shall be controlled to the limits specified (see 3.4.3).

Cleanliness shall be maintained during processing, storage, and transportation using appropriate protective containers or covers. Explosive ordnance shall be stored and transported in sealed packages using antistatic wrapping material where appropriate. The antistatic wrapping material used should not produce nonvolatile residues. The antistatic wrapping material shall be grounded through a resistor prior to removal. The grounding resistor shall have a value between 100,000 ohms and 1 megohm.

4. QUALITY ASSURANCE PROVISIONS

4.1 **Responsibility** for Inspections and Tests. Unless otherwise specified in the contract, the supplier is responsible for the performance of all inspection and test requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection and test requirements specified herein, unless disapproved by the government. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.1.1 Responsibilitv for Compliance. All items must meet all requirements of Section 3. The inspections set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract.

4.1.2 Test Equipment and Inspection Facilities. The manufacturer shall insure that test and inspection facilities of sufficient accuracy, quality, and quantity are established and maintained to permit performance of required inspections.

4.2 Classification of Inspections and Tests. The tests and inspections specified herein are classified as follows:

a. Parts, materials, and process controls (4.3)

b. Design verification tests (4.4)

c. Qualification tests (4.5)

d. Lot Acceptance tests (4.6)

e. Service life verification tests (4.7)

4.3 Parts, Materials, and Process Controls. To ensure that a reliable explosive ordnance component is manufactured, all parts and materials shall be adequately controlled and inspected prior to assembly. Verification of material outgassing shall be in accordance with ASTM E 595-84. During fabrication, the tools and processes, as well as parts and materials, shall be adequately controlled and inspected to ensure compliance with the approved manufacturing processes and controls.

4.3.1 Part Qualification. Parts, such as detonators and other explosive elements, used in safe and arm devices or other assemblies shall be acceptance and qualification tested as separate items. Detonators and other explosive elements shall be from a production lot that have a verified service life for the scheduled operational use.

4.3.2 Records. Records documenting the accreditation status of the explosive ordnance components shall be maintained following assignment of serial numbers. Each item shall have inspection records and test records maintained by serial number to provide traceability from system. usage to assembly lot data for the device. Complete records shall be maintained and shall be available for review during the service life of the system. The records shall indicate all relevant test data, all rework or modifications, and all installation and removals for whatever reason.

4.3.3 **Manufacturing Screens.** Each unit in all production lots of explosive ordnance shall be subjected to in-process production screens to assure compliance with the established manufacturing process control baseline and the specified requirements to the extent practicable. The compliance with the documented process controls, documented screening requirements, required hardware configuration, and general workmanship requirements shall be verified. Each completed unit shall be subjected to visual inspection to assure that it is free of obvious defects. Each completed unit shall be subjected to a dimensional check to verify that it is within specified physical limits. Completed EEDs shall, as a minimum, also be subjected to the following additional screens:

a. N-ray examination to detect critical internal defects such as in plastic parts or hydrocarbons where N-ray examination can be perceptive.

b. X-ray radiographic examination to detect critical internal defects, such as entrapped metallic particles.

c. Leak tests to assure seal effectiveness.

d. Bridgewire resistance within 10 percent of the design value.

e. Electrostatic sensitivity.

f. Electrical insulation resistance.

4.3.4 Nonconforming Material. Nonconforming material or assembled units that do not meet the established tolerance limits set for the production screens shall be removed from the production lot. Nonconforming material or assembled units may be reworked and rescreened in accordance with established procedures if the rework is not so extensive as to jeopardize the production lot identity of the material or assembled unit. If the reworked material or assembled unit subsequently passes the production screens, it can again be considered part of the production lot. Nonconforming material or assembled units that do not satisfy this rework criteria shall be considered scrap. Reassignment of assembled production units to a different production lot shall not be made.

4.4 Design Verification Tests. Design verification tests shall be performed to demonstrate compliance of new designs or of modified designs with the specified performance margins (see 3.3). Alternate test methods to those indicated herein for margin demonstration may be used if approved by the acquisition activity. Test units shall be sufficiently similar to the final production units as to not jeopardize the validity of the test results.

4.4.1 Cartridge Actuated Device Performance Margins

4.4.1.1 Minimum Charge Weight. The ability of cartridge actuated devices to operate successfully with a minimum explosive charge shall be verified by firing a minimum of five devices containing a charge which is 80 percent or less of the minimum specified charge weight. If redundant cartridges are used in the device, only one cartridge shall be active and the other shall be inert. The tests shall be conducted at the specified lowest design operating temperature using 3 units, and at the highest temperature using 2 units. A satisfactory margin is demonstrated only if all tests are successful.

4.4.1.2 Maximum Charse Weiaht. The ability of cartridge actuated devices to withstard an overcharge shall be demonstrated by firing a minimum of five devices containing a charge which is at least 120 percent of the maximum specified charge weight and with no increase in internal free volume. If redundant cartridges are used in the device, both cartridges shall be active. The tests shall be conducted at the specified highest design operating temperature, 3 units, and at the lowest temperature, 2 units. A satisfactory margin is demonstrated only if all tests are successful.

4.4.1.3 Mechanical Load. The ability of cartridge actuated devices, to function while under load shall be verified by firing two devices at the highest design operating temperature and three devices at the lowest temperature while under no load and a minimum of two devices at the lowest design operating temperature and three devices at the highest temperature while under a load greater than 1.5 times the maximum operating load. A satisfactory margin is demonstrated only if all tests are successful.

4.4.2 Severing and Penetrating Explosive Charge Performance Margins. The ability of severing and penetrating explosive charges to perform with an adequate margin shall be demonstrated by one of the following two tests:

a. A minimum of five charges at the nominal operating temperature shall be test fired using 1.5 times the maximum thickness of the specified material at the maximum standoff. A satisfactory margin is demonstrated if the specified penetration or severance is achieved with all charges.

b. A minimum of five charges using 67 percent or less of the minimum specified explosive charge, at the nominal operating temperature, should be test fired using the maximum thickness of the specified material at the maximum standoff. A satisfactory margin is demonstrated if the specified penetration or severance is achieved with all charges.

4.4.3 Detonation Transfer Performance Marqins (Except for Through Bulkhead Initiators). The ability of the detonating donor to propagate the detonation to the receptor shall be demonstrated by one of the following methods:

a. A minimum of 10 firings using a donor charge which is 75 percent or less of the minimum specified charge and at the nominal operating temperature shall be conducted. Half of these test firings shall be conducted using the minimum specified air gap and half conducted using the maximum specified air gap. A satisfactory margin is demonstrated if all tests are successful.

b. A minimum of 10 firings using the specified nominal donor charge and at the nominal operating temperature shall be conducted. Half of these test firings shall he conducted using an air gap that is at least four times the maximum design air gap width or a 2.54 millimeters (0.10 inch) gap, whichever is greater, plus 1.25 millimeters, and half conducted using an air gap that is 50 percent of the minimum design air gap. A satisfactory margin is demonstrated if all tests are successful.

4.4.4 <u>Detonation. Transfer Performance Margins for Through Bulkhead Initiators</u>. The ability of Through Bulkhead Initiators to initiate the receptor charge through a bulkhead 1.20 times the maximum specified thickness shall be demonstrated by a minimum of six test firings using the nominal charge. Half of these tests shall be fired at the highest design operating temperature and half of these tests shall be at the lowest design operating temperature. The ability of Through Bulkhead Initiators to initiate the detonation through the minimum thickness bulkhead without causing leakage shall be demonstrated by a minimum of three test firings. These tests shall be fired at the highest design operating temperature using the maximum specified charge through a bulkhead that is 80 percent of the minimum specified thickness. A satisfactory margin is demonstrated if all tests are successful.

4.4.5 <u>EED Current Time</u>. The effect of current on the firing time shall be demonstrated by testing the EEDs at various current levels from the specified All-fire current up to 22.0 amps. A minimum of four current levels shall be tested using 5 EEDs at each level.

4.4.6 <u>Verification of Nonoperating Constraints</u>. The effects of nonoperational environments on the explosive ordnance may be determined by nonoperating development tests. These tests would be used to identify fabrication, storage, handling, transportation, installation, and launch preparation constraints or controls that may be necessary. Approval of the acquisition activity is required if it is necessary to provide special nonoperating environmental controls other than those specified herein.

4.4.7 <u>Test Fixtures</u>. The fixtures required for the testing of explosive ordnance shall be designed to simulate the intended applications.

4.5 <u>**Qualification** Tests</u>. Qualification tests shall be performed to demonstrate, tr the extent it is practicable, that explosive ordnance meets the specified design requirements. The 6 dB, 10 deg C, or other design factors of safety or margins specified herein include test condition tolerances that are those allowed in MIL-STD-1540. All qualification tests shall be conducted with hardware of the final design that have been manufactured in accordance with the parts, materials, processes, and controls specified (see 4.3) and that have passed all in-process production screens. Note that the qualification test requirements for **EEDs** are separate from the qualification test requirements for other explosive ordnance. When a component and its associated EED both require qualification testing, the component testing and the EED testing may be combined to reduce the total test program. However, the total test program shall satisfy all requirements specified for EED qualification as well as for component qualification.

4.5.1 <u>Qualification Tests for **EEDs**</u>

4.5.1.1 <u>Test Program</u>. The qualification test program for **EEDS** shall include the nondestructive EED lot acceptance testing of all units in accordance with Table I and the testing of 216 units in accordance with Table II. The entire production lot shall be rejected if there are any test failures of the 216 units during the Table II tests.

4.5.1.2 <u>Firinu tests</u>. The firing tests for all **EEDs** shall be conducted at the specified currents.

4.5.1.2.1 <u>Detonatins **EEDs**</u>. The firing tests for **EEDs** containing a detonating main charge shall include measurements of output using a dent test. Current versus firing time shall be measured on all functioning tests.

4.5.1.2.2 <u>Deflauratina **EEDs**</u>. The firing tests for **EEDs** containing a deflagrating main charge shall be fired in a closed bomb. Measurements using redundant instrumentation shall include pressure versus time and current versus time.

4.5.2 <u>Qualification Tests for Explosive Ordnance (Except **EEDs)**</u>

4.5.2.1 <u>Test Prouram</u>. The qualification test program for explosive ordnance other than **EEDs**, such as separation nuts, cutters, pin pullers, valves, and linear charges, shall include the testing of 27 units in accordance with Table IV. The entire production lot shall be rejected if there are any test failures, 4.5.2.2 **Firing Tests**. The firing tests for explosive ordnance other than EEDs shall be designed to simulate actual operational installations and shall be conducted to demonstrate the ability of the component to perform to the design requirements. The firing tests shall include a measurement of firing time. Components operating on gas pressure from a deflagrating charge which contain redundant charges shall use both charges when tested at high temperature and shall use only one charge when tested at low temperature. If either of these conditions do not represent the worst case conditions, the device shall also be tested under the worst case conditions. Detonating components, such as linear explosive charges, shall be tested using one EEG. Firing tests of linear charges shall include instrumentation to measure detonation velocity.

4.5.2.3 Structural Loads. Tests shall be conducted to verify the adequacy of the limit and ultimate loads for structural components such as separation nuts and bolts.

4.5.3 Qualification of Existing Designs. It may be possible to show that existing designs, or items previously qualified for other applications, have adequately demonstrated compliance to all qualification requirements stated herein for new designs. Deficiencies in meeting all of the requirements may be fulfilled by supplementing the existing data with new test data. Requalification is required for items that incorporate extensive changes in design, manufacturing processing, environmental levels, or other requirements. Waiver of qualification or requalification requirements requires the approval of the acquisition activity. Qualification by similarity shall be permitted only with the concurrence of the acquisition activity.

4.6 Lot Acceptance Testing. Lot acceptance testing shall be performed as the basis for lot acceptance on each production lot manufactured after the qualification lot. Lot acceptance testing is that testing performed to demonstrate that a production lot of explosive ordnance that has passed the production screening also meets the other requirements of this specification. Items submitted for lot acceptance shall have been manufactured using the same supplier documented processes and controls as used for the qualification tests units. Acceptance test environmental levels shall be the same as the qualification test environmental levels. Lot acceptance of a production lot is achieved by the satisfactory completion without failure of the applicable tests described in 4.6.1, 4.6.2, or 4.6.3.

4.6.1 **EEDs**. The lot acceptance test program for EEDs shall consist of the firing tests of a lot sample of 30 EEDs or

10 percent of the lot, whichever is greater, randomly selected. Testing shall be conducted in accordance with Table V. The entire production lot shall be rejected if there are any test failures.

4.6.2 Explosive Ordnance (Other Than EEDs). The lot acceptance testing of other explosive devices shall consist of the firing tests of a lot sample of nine devices, or 10 percent of the lot, whichever is greater, randomly selected. Testing shall be conducted in accordance with Table VII. The entire production lot shall be rejected if there are any test failures.

4.6.3 Combined Tests Because the lot acceptance tests are similar to the qualification tests, but require a smaller number of units, combined testing is recommended. For example, the initial production lot is normally used for qualification testing so no additional lot acceptance testing would be required for the remaining units in that initial production lot. Separate lot acceptance tests would, therefore, only be required for follow-on production lots.

4.7 Service Life Verification Tests. Service life verification tests are defined as those tests conducted to demonstrate that each production lot of components containing explosive materials will perform satisfactorily during their specified service life. Lot acceptance testing establishes an initial 1 year of authorized service life for the remaining units in that production lot. Following this initial 1 year, additional service life shall be demonstrated by successful completion of either aging surveillance tests conducted annually in accordance with Table VIII or by accelerated aging tests conducted every 3 years in accordance with Table IX. The accelerated aging test, Table IX, may be conducted at the time of acceptance for an initial three year service life. Any remaining units in the production lot shall be rejected if there are any test failures. There is no limit on the number of successful service life verification tests that can be performed on a production lot. Service life testing does not need to be conducted every year, or every three years, as described in this paragraph, provided the aging surveillance tests or the accelerated aging tests are successfully accomplished within one or three years respectively prior to use of the ordnance device.

4.7.1 EED Surveillance Test A randomly selected sample of five components from each lot *shall be tested yearly until the lot is exhausted. The procedure shall be as described in Table VIII.

4.7.2 EED Accelerated Auina Test. Ten randomly selected explosive ordnance components shall be stored at 71 $\pm$ 5 deg C for 28 days to accelerate the normal aging process. The tests and methods described in Table IX shall be used for this test. Successful completion of this testing shall result in a 3-year extension of the useful life for the remaining units from the production lot assuming they will be stored at 21 ± 20 deg C. This test shall be repeated at the end of every 3 years to extend the life of existing hardware. This test may be tailored by adjusting the duration of storage to obtain other service life assignments.

4.7.3 Other Explosive Components. Surveillance testing of other explosive components, which would include transfer charges, mild detonating cord, linear shaped charge, prima line and prima cord, shall be conducted as appropriate. Table X contains a recommended procedure for these tests.

5. PACKAGING (Not Applicable)

6. NOTES

6.1 Intended use. Items covered by this specification are intended for use in space vehicles or in equipment with high reliability requirements. The requirements stated in the specification are a composite of those that have been found to be cost effective for high reliability space vehicle applications. Because of the similarity of requirements, this specification may be used to specify requirements for explosive ordnance for launch vehicles, intercontinental ballistic missiles, reentry vehicles, or other vehicles. For these applications the term "space vehicle" is to be interpreted as the applicable vehicle.

The general manufacturing process control requirements are intended to assure that a known quality product is manufactured and that all units in all production lots will have a uniform high reliability. There are specific production screening requirements and specific lot acceptance requirements stated for EEDs to be used in applications associated with the National Space Transportation System (NSTS). The requirements stated for these EEDs are intended to meet the safety requirements established by NASA for NSTS applications. EEDs that satisfy the requirements included herein for STS applications may be used in other DoD applications.

The specification imposes the concept of product flight accreditation (see 3.1) to assure that these critical "one-shot" explosive ordnance components satisfy all requirements that have been found necessary to assure successful space vehicle missions. Note that items certified by NASA for use on the NSTS or items furnished by other government agencies (GFE) may require additional testing or controls to satisfy the flight accreditation requirements of 3.1.

6.2 Tailored Application. Where possible, the requirements in the specification are stated in ways that are self-tailoring to each application. However, additional tailoring of the requirements should be considered throughout the acquisition process within the constraints of the major program elements. These elements typically include performance, testing, reliability, schedules, production costs, operating costs, maintenance costs, and other high cost drivers in the projected life cycle. Contractors are encouraged to identify to the acquisition activity, for program office review and reconsideration, any requirements imposed by this specification that are believed excessive. However, contractors are reminded that deviations from contractually imposed requirements can be granted only by the acquisition activity. Note that referenced test methods are usually stated in this specification as suggestions, not as mandatory requirements.

It is intended that detailed specifications prepared for the procurement of specific devices would reference this general specification to incorporate the applicable requirements. An attempt was made to state the requirements in ways that would be self-tailoring to the specific applications without paragraph referencing. For example, requirements are identified for:

a. EEDs,

b. Other explosive ordnance, and

c. Space vehicle applications

If a space vehicle specification states that explosive ordnance "shall be in accordance with DOD-E-83578" then all requirements stated in this specification are applicable. If a detailed specification for an EED states that the EED "shall be in accordance with DOD-E-83578" then only the EED requirements stated in this specification would be made applicable by that reference. Additional tailoring statements would not be required to eliminate the vehicle requirements or the requirements for other explosive ordnance. Requirements stated for other types of EEDs, for other components, or for the vehicle are not made applicable by such a reference.

6.3 Definitions

6.3.1 Acceptor. An acceptor (AKA receptor) is an explosive element which receives a detonating impulse from a previously exploded element, called a donor, and serves to propagate the detonation.

6.3.2 Acquisition Activity. The acquisition activity is the Government office or agency acquiring the equipment, system, or subsystem for which this document is being contractually applied.

6.3.3 All-fire Current. The all-fire current is the lowest level of current which results in initiation with a reliability of 0.999 at a 95 percent confidence level.

6.3.4 Batch. A batch is a quantity of explosive material which has been prepared as a unit by a chemical process or physical mixing process.

6.3.5 Booster Charge. A booster charge is an explosive charge augmenting the initiating charge of an explosive train to cause ignition or detonation of the main explosive charge or to increase the output of the assembly.

6.3.6 Bridgewire. A bridgewire is a resistance wire incorporated into explosive ordnance to convert electrical energy into heat to cause ignition of the explosive charge.

6.3.7 Cartridge. A cartridge is an explosive device designed to produce pressure for performing a mechanical function, i.e., operating a cartridge actuated device such as a pin puller or cable cutter. A cartridge may be the first, or only, explosive element in an explosive train and thus be considered an initiator. Electrically actuated cartridges are EEDs.

6.3.8 Cartridge Actuated Device. A cartridge actuated device is a mechanism which employs the energy produced by an explosive charge to perform or initiate a mechanical action. Examples are: pin puller, cable cutters, separation nuts, and explosive valves.

6.3.9 Charge. A charge is a quantity of explosive loaded in an initiator, detonator, cartridge or other items containing explosives.

6.3.10 Charge. Linear Explosive. A linear explosive charge is a relatively long explosive charge contained in a metal or plastic sheath. Linear explosive charges may be cylindrical or contained in a "V" groove. They are generally less than 5 millimeters in diameter and may be many meters in length. Uses include severing materials and transferring detonation or deflagration.

6.3.11 Charae. Penetrating. A penetrating charge is an assembly containing an explosive charge loaded in a shaped casing, generally an inverted cone, which when fired, produces a penetrating jet action. Penetrating charges are typically used for destruct systems.

6.3.12 Charge, Severing. A severing charge is a linear explosive charge used to fracture or cut metal or other materials. It is typically used for separating functions.

6.3.13 Cook-off Temperature. The cook-off temperature is the lowest temperature that will cause a detonation or deflagration of an explosive material.

6.3.14 Crossover. A crossover is an explosive connecting link between redundant explosive trains.

6.3.15 Deflagration. Deflagration is very rapid combustion. Although classed as an explosion, deflagration generally implies the burning of a substance with self-contained oxygen so that the reaction zone advances into the unreacted material at less than the velocity of sound in the unreacted material.

6.3.16 Destruct Charse. A destruct charge is an explosive assembly, generally a penetrating charge assembly, used to destroy errant vehicles.

6.3.17 Detonation, High Order. A high order detonation is a chemical reaction that propagates with such rapidity that the rate of advance of the reaction zone into the unreacted material exceeds the velocity of sound in the unreacted material. A detonation is classed as an explosion. The rate of advance of the reaction zone is termed detonation rate or detonation velocity. When this rate of advance attains such a value that it will continue without diminution through the unreacted material, it is termed the stable detonation velocity.

6.3.18 Detonation, Low Order. A low order detonation is a chemical reaction where the reaction rate is lower than the stable detonation velocity and higher than the reaction rate of a deflagration. An explosive charge which detonates low order is usually incapable of initiating a high order detonation in a succeeding secondary explosive charge.

6.2.19 Detonator. A detonator is an initiator for high order detonating explosives. Detonators used in space vehicles are generally EEDs, i.e., electrically actuated.

6.2.20 Donor. A donor is an explosive charge which transmits a detonating impulse out of the detonating charge into a succeeding explosive element, the acceptor.

6.3.21 Dud. A dud is an explosive charge or component that fails to fire or function upon receipt of the prescribed initiating stimulus.

6.3.22 EED (Electroexplosive Device). An electroexplosive device is an explosive initiator that is electrically actuated. The EED is the explosive element used to operate a cartridge actuated device, to initiate an explosive charge, or to ignite a deflagrating material. Detonators, squibs, and cartridges when electrically actuated are EEDs.

6.3.23 Explosion. An explosion is a chemical reaction which is effected in an exceedingly short space of time, with the generation of a high temperature and generally a large quantity of gas. The term includes both deflagration and detonation.

6.3.24 Explosive. An explosive is a generic term for materials that explode and includes deflagrating materials and detonating materials.

6.3.25 Explosive Bolt. An explosive bolt is a bolt that is intended to be fractured at a predetermined point by a contained or inserted explosive charge.

6.3.26 Explosive Ordnance. For the purpose of this document, explosive ordnance is defined as any component or assembly containing, or operated by, an explosive material.

6.3.27 Explosive Train. An assembly of explosive charges that interact to perform a function such as combinations of EEDs, donors, receptors, boosters, and other explosive charges. An ETA is an example of an explosive train.

6.3.28 Explosive Transfer Assembly (ETA). An explosive transfer assembly is an explosive train consisting of an assembly of linear charges used to transfer a detonation from an initiator to an end function. The purpose of the ETA is to allow the initiator to be located away from the end function for accessibility. An example is a solid motor igniter, located inside a spacecraft, connected to the initiator, located on the exterior of the spacecraft, by an ETA.

6.3.29 Initiator. An initiator is the first element in an explosive train which, upon receipt of the proper mechanical or electrical impulse, produces a deflagrating or detonating action. The deflagrating or detonating action is transmitted to the following elements in the train. Initiators may be mechanically actuated, percussion primers, or electrically actuated (EEDs).

6.3.30 Lead. A lead is an explosive charge contained in a can or in pellet form used within a device to transfer a detonation from one point to another. An example is a rotor charge used in safe and arm devices.

6.3.31 Linear shaped charge. A linear shaped charge is a linear explosive charge contained in a metal sheath with a "V" groove to direct the explosive output and is used for cutting metal or other materials..

6.3.32 No-fire. The "No-fire" current or "No-fire" power is the current or power that produces, in the specified time period, the maximum input energy level at which an EED will not fire or degrade with a reliability of 0.999 at 95 percent confidence level.

6.3.33 NSI (NASA Standard Initiator). The NSI is an EED. The term NSI may only be used when the EEDs have been certified by NASA.

6.3.34 Percussion. Percussion is a method of initiating the explosive reaction by an intentional sudden pinching or crushing of the explosive material, as between a blunt firing pin and an anvil.

6.3.35 Primary Explosive. A primary explosive is an explosive material which is extremely sensitive to heat or shock as the initiating mechanism, such as azides and styphnates. Primary explosives are normally used in initiators.

6.3.36 Production Lot A production lot is a group of assemblies or devices of a'single type and size fabricated at one place in a continuous manufacturing process using the same tooling and the same material batches.

6.3.37 Receptor. Receptor is another name for an acceptor charge.

6.3.38 Recommended Firing Current . The recommended firing current is the current recommended to be applied to an electroexplosive device to cause initiation of the explosive charge and which provides a margin over the "all-fire" current specified for the device.

6.3.39 Safe and Arm Device. A safe and arm device is a mechanical or electromechanical device which in the safe condition renders the explosive device electrically and mechanically safe, i.e., the initiating circuitry and the explosive train are both interrupted. When in the arm condition, the safe and arm device renders the explosive device operative and ready to fire when initiated.

6.3.40 Secondary Explosive. A secondary explosive is an explosive material that is relatively insensitive to heat or impact and must be initiated by a suitable primary explosive or another secondary explosive.

6.3.41 Sensitivity. Sensitivity is the characteristic of an explosive or charge which expresses its susceptibility to initiation by externally applied energy such as heat, mechanical shock, or other stimuli.

6.3.42 Service Life. The service life is the period of time extendinq from the date of manufacture of the explosive ordnance to a date when the assembly is considered no longer acceptable for flight.

6.3.43 Squib. A squib is a general term that is used for any one of many small explosive devices that are loaded with deflagrating explosive so that the output is primarily gas and heat. Squibs may be initiators for gas generators and igniters or may be cartridges for cartridge actuated devices. Electrically actuated squibs are EEDs.

6.3.44 Through Bulkhead Initiator. A through bulkhead initiator is a high order detonation transfer element which propagates the detonation through an integral metal bulkhead by transmitting shock waves from the donor side to the acceptor side. The through bulkhead initiator is generally used where complete sealing is needed between explosive elements after firing.

6.3.45 Traceability. Traceability is the requirement to provide the means of determining when and where each element of an explosive train was manufactured.

6.4 Bruceton Method. The Bruceton method of determining the firing characteristics of initiators, as described in NAVORD 2101, results in a good approximation of the 50 percent "fire," 50 percent "no-fire," energy levels. The Bruceton test should be used to demonstrate compliance with the Range Safety Regulations, WSMCR 127-1 and ESMCR 127-1. In using these data as a guide to establish recommended operational firing levels for initiators, adequate margins shall be incorporated to compensate for the inherent inaccuracy of the "all-fire" data. Bruceton data should not be used to demonstrate component reliability.

6.5 Subject Term (Key Word) Listing

All-fire
Bridgewire
Cartridge Actuated

Detonation Transfer
Electroexplosive
Explosive Ordnance
Explosive Trains
Initiator
No-fire
Penetrating
Severing
Shaped Charges
Through Bulkhead

6.6 **Supersession Data.** This issue of DOD-E-83578 is a complete revision that supersedes all previous issues of DOD-E-83578 for new designs. The previous issues of DOD-E-83578 remain in effect to cover the procurement of previously designed equipment.

Custodian:
Air Force - 19

Preparing Activity
Air Force - 19

(Project No. 1820 - F016)
Doc 1264b Arch 1226b

TABLE I. Nondestructive EED Lot Acceptance Tests

TEST	MIL-STD-1576 PROCEDURE	QUANTITY
Visual Inspection	Method 1101	100 percent
Dimensional Check	Method 1102	100 percent
Bridgewire Resistance *	Method 2201	100 percent
Leak Test	Method 1111	100 percent
Static Discharge	Method 2205	100 percent
Insulation Resistance	Method 2117	100 percent
Bridgewire Resistance	Method 2201	100 percent
K-ray	Method 1103	100 percent
N-ray	Method 1404	100 percent

TABLE FOOTNOTE

* This bridgewire test may be omitted if bridgewire testing was conducted after loading and recorded measurements are available. Items which fail any of the above tests shall be considered nonconforming assembled units and dispositioned per Paragraph 4.3.4. A failure rate of 5 percent or more for any one test shall trigger an appraisal of the lot status.

TABLE II. EED Qualification Testing

TEST	MIL-STD-1576 PROCEDURE	NUMBER OF EEDs TESTED AS FOLLOWS						
Nondestructive Tests*	TABLE I	45	45	5	6	5	5	105
No-fire Bruceton (5 minute constant current)	Method 2203	** 45						
All-fire Bruceton (30 millisecond constant current)	Method 2203		** 45					
High Temperature Exposure	Method 3404			** 5				
Temperature Cycling	Method 3407					5	5	105
Shock	Method 3114						5	105
Vibration	Method 3113							105
Drop Test (2 meters)	Method 3409				6			
Bridgewire Resistance	Method 2201				6	5	5	105
Insulation Resistance	Method 2117				6	5	5	105
Leak Test	Method 1111				6	5	5	105
X-ray	Method 1103				6	5	5	105
N-ray	Method 1404				6	5	5	105
No-fire Verification	Method 2404				6	5	5	105
Ambient Firing Test	At specified All-fire Per Method 2405				** 6	5	5	
Temperature Firing Tests	Test per Table III							** 105

TABLE FOOTNOTES

* All 216 **EEDs** submitted to qualification must have passed nondestructive acceptance tests of TABLE I.

** The ** and the line under number of **EEDs** (such as ** 105) indicates those **EEDs** are considered destroyed by the test.

TABLE III. Lot Sample Allocation for Temperature Firing Tests

Firing Temperature	All-fire Current	Predicted 1/ Operating Current	22 Amps
- Ambient Temperature	15	15	5
- High Temperature 2/	15	15	5
- Low Temperature 3/	15	15	5

TABLE FOOTNOTES

1/ In the event that firing current cannot be predicted, these EEDs shall be tested at 2 times the specified all-fire current.

2/ Fire at the predicted high temperature or at +71 deg C, whichever is higher.

3/ Fire at the predicted low temperature or at -57 deg C, whichever is lower.

TABLE IV. Explosive Ordnance (other than EEDs) Qualification Tests

	SUGGESTED METHOD 1/ MIL-STD-1576	TEST QUANTITIES 2/	
Visual Inspection	Method 1101	6	21
Dimensional Check	Method 1102	6	21
Temperature Cycling	Method 3407	6	21
Shock	Method 3114		21
Vibration	Method 3113		21
Firing Tests			
- Ambient Temperature		2	7
- High Temperature 3/		2	7
- Low Temperature 4/		2	7

TABLE FOOTNOTES

1/ The test methods indicated are suggestions for use in establishing detailed requirements applicable to specific devices.

2/ A total of 27 devices are required for qualification. The quantities for each test or test sequence are as indicated.

3/ Fire at the predicted high temperature or at +71 deg C, whichever is higher, and at the predicted operating current.

4/ Fire at the predicted low temperature or at -57 deg C, whichever is lower, and at the predicted operating current.

5/ X-ray or N-ray inspections, or both, should be used where appropriate

TABLE V. EED Lot Acceptance Testing

TEST	MIL-STD-1576 PROCEDURE	QUANTITY
Nondestructive Tests	TABLE I	100 percent of lot
Temperature Cycling	Method 3407	Lot Sample *
Shock	Method 3114	Lot Sample *
Vibration (Use qualification level)	Method 3113	Lot Sample *
X-ray	Method 1103	Lot Sample *
N-ray (optional)	Method 1404	Lot Sample *
Bridgewire Resistance	Method 2201	Lot Sample *
Insulation Resistance	Method 2117	Lot Sample *
Leak Test	Method 1111	Lot Sample *
No-fire Verification	Method 2402	Lot Sample *
Firing Tests	Method 2405	Lot Sample * Per TABLE VI

TABLE FOOTNOTE

* The Lot Sample is 10 percent of the Lot but not less than 30.

TABLE VI. Lot Sample Allocation for Temperature Firing Tests 1/

Firing Temperature	All-fire Current	Predicted 2/ Operating Current
Ambient Temperature	1/6 Lot Sample	1/6 Lot Sample
Predicted High Temp 3/	1/6 Lot Sample	1/6 Lot Sample
Predicted Low Temp 4/	1/6 Lot Sample	1/6 Lot Sample

TABLE FOOTNOTES

1/ The Lot Sample is 10 percent of the Lot but not less than 30.

2/ In the event that the operating current cannot be predicted the test level current shall be twice the all-fire current.

3/ Fire at the predicted high temperature or at +71 deg C, whichever is higher.

4/ Fire at the predicted low temperature or at -57 deg C, whichever is lower.

TABLE VII. Explosive Ordnance (Other than EEDs) Lot Acceptance Tests

TEST	SUGGESTED METHOD 1/ MIL-STD-1576	QUANTITIES 9 2/
Visual Inspection	Method 1101	9
Dimensional Check	Method 1102	9
Temperature Cycling	Method 3407	9
Shock	Method 3114	9
Vibration	Method 3113	9
Firing Tests		
- Ambient Temperature		3
- High Temperature 3/		3
- Low Temperature 4/		3

TABLE FOOTNOTES

1/ The test methods indicated are suggestions for use in establishing detailed requirements applicable to specific devices.

2/ The lot acceptance test quantity shall be nine devices, or 10 percent of the lot acceptance test, whichever is greater.

3/ Fire at the predicted high temperature or at +71 deg C, whichever is higher.

4/ Fire at the predicted low temperature or at -57 deg C, whichever is lower.

TABLE VIII. EED Surveillance Test

NOTE: When surveillance tests are used to verify the service life requirements of Subsection 4.7, testing shall be conducted one year after lot acceptance testing and each year thereafter to extend service life for an additional year. Testing may be deferred when there is no planned use of EEDs for a long period of time.

TEST	MIL-STD-1576 PROCEDURE	QUANTITY
Nondestructive Tests	TABLE 1	5
Temperature Cycling	Method 3407	5
Shock	Method 3114	5
Vibration (Use qualification level)	Method 3113	5
X-ray	Method 1103	5
N-ray (optional)	Method 1404	5
Bridgewire Resistance	Method 2201	5
Insulation Resistance	Method 2117	5
Leak Test	Method 1111	5
No-fire Verification	Method 2402	5
Firing Test - Ambient Temperature	Fire at specified all-fire current per Method 2405	5

TABLE IX. EED Accelerated Aging Test

NOTE: When accelerated aging tests are used to verify the service life requirements of Subsection 4.7, testing shall be conducted at time of lot acceptance, Successful completion of this testing merits a three year service life assignment. This procedure may be repeated at three year intervals to extend service life for an additional three years.

TEST	MIL-STD-1576 PROCEDURE	QUANTITY
Nondestructive Tests	TABLE I	10
High Temperature Storage	Method 3403	10
Shock	Method 3114	10
Vibration (Use qualification level)	Method 3113	10
X-ray	Method 1103	10
N-ray	Method 1404	10
Bridgewire Resistance	Method 2201	10
Insulation Resistance	Method 2117	10
Leak Test	Method 1111	10
No-fire Verification	Method 2402	10
Firing Tests at Specified All-fire Current		
- Ambient Temperature	Method 2405	4
- High Temperature 1/	Method 2405	3
- Low Temperature 2/	Method 2405	3

TABLE FOOTNOTES

1/ Fire at the predicted high temperature or at +71 deg C, whichever is higher.

2/ Fire at the predicted low temperature or at -57 deg C, whichever is lower.

TABLE X. Surveillance Test for Other Explosive Components

Test	Procedure	Quantity 1/
Visual Inspection	1101	5
Temperature Cycling	3407	5
Leak Test (Optional)	1111	5
Firing Test		
High Temperature		2
Low Temperature		3

1/ The quantity shall be five samples total as shown unless a determination is made, based on the type of component to be tested, that a smaller sample size is adequate. Two samples is the minimum quantity, with one fired at high temperature, and one fired at low temperature. For example, for linear charges, one sample from each end of the linear charge is usually adequate making a total of two samples. For some other types of components an adequate sample size might be three or four.

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3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION *(Mark one)*

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